

## The long-term effects of daily rinsing with stannous fluoride or sodium fluoride on bacteria in dental plaque

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### Abstract

Microbial parameters were studied in the plaque of 88 subjects between the ages of 14 and 17 years who had rinsed daily with either 0.1% stannous fluoride or 0.05% sodium fluoride for 28 months. Plaque was collected from specific sites, dispersed, diluted, and cultured to estimate total numbers of plaque organisms and proportions of streptococci, *Streptococcus mutans* and *Veillonella*. While prior studies had indicated that rinsing with stannous fluoride would decrease numbers of *S. mutans* and increase numbers of *Veillonella* compared to those in subjects rinsing with sodium fluoride, no significant differences were observed in this study.

In addition to its caries-preventive effects, stannous fluoride has been shown to reduce plaque formation. Inhibitory effects on plaque were first demonstrated in rats by König (1959) and later confirmed by Shern et al. (Shern and Couet 1977; Shern et al. 1978). Short-term human studies have shown that stannous fluoride mouthrinses reduce plaque formation.<sup>1</sup> Of particular interest is the demonstration of a significant reduction in numbers of *Streptococcus mutans* in dental plaque, in view of the important role that this organism plays in the etiology of dental caries. Such an effect was demonstrated in a small group of subjects with high caries activity who rinsed twice daily with stannous fluoride for two years (Klock et al. 1985). In a similar group of subjects in the same study who rinsed with sodium fluoride, there was no change in *S. mutans* levels in plaque.

*Veillonella* are commonly found in plaque, constituting about one-third of total viable organisms (Mays and Johnson 1977), and have been found in higher numbers in children with low caries activity who consumed water containing excessive (i.e., 3-21 ppm) amounts of fluoride (Kilian et al. 1979).

<sup>1</sup> Andres et al. 1974; Svaton et al. 1977; Tinanoff et al. 1980; Leverett et al. 1981; Svanberg and Rølla 1982; Tinanoff et al. 1983.

The present investigation was designed as a cross-sectional study to compare the levels of *S. mutans* and *Veillonella* in plaque after long-term daily rinsing with stannous fluoride or sodium fluoride having similar fluoride concentrations.

### Material and Methods

Subjects for this study were selected from a larger population of children who rinsed daily under supervision on school days with either a 0.05% aqueous NaF solution (226 ppm F) or a 0.1% aqueous SnF<sub>2</sub> solution (242 ppm F). A total of 175 subjects in the NaF group and 176 subjects in the SnF<sub>2</sub> group had maintained this regimen for 28 months. Details of this study have been reported earlier (Leverett et al. 1981, 1984). The subjects for whom data now are being reported were selected from these larger groups according to two criteria.

1. They had to have been "regular rinsers" as evidenced by records that they had actually rinsed under supervision on at least 75% of all possible rinse days during the 28-month period.
2. They had at least one active carious lesion at the time of final examination.

A total of 46 children in the SnF<sub>2</sub> rinse group and 42 in the NaF group met these two criteria. Their ages ranged from 14 to 17 years at the time of the examination at the end of 28 months of rinsing. Plaque was collected from the buccal aspect of the proximal surfaces of the lower right molar and premolar teeth with sterile Jacques® scalers. The plaque samples were placed in cold reduced transport medium (Loesche et al. 1973), capped tightly, and kept at 10° C until delivery to the laboratory. On arrival, they were brought to 20 ml and dispersed by sonication (3 bursts of 10 sec duration each). Serial 10-fold dilutions then were made with the transport medium and agar plates were spotted with 20 µl of each dilution by the method of Westergren and Krasse (1978). Blood agar, veillonella agar, mitis salivarius agar, and m. salivarius agar with bacitracin (MSAB -

Gold et al. 1973) were used for enumeration of total viable flora, *Veillonella*, and *S. mutans*. The plates were incubated anaerobically for 48 hr at 37° C and colonies counted with a binocular microscope. Blood agar plates were incubated for an additional 24 hr before counting.

As reported previously, Plaque Index, Gingival Index, Stain Index, and DMFS scores were recorded for each subject at baseline and after four, 16, and 28 months (Leverett et al. 1981, 1984, 1986).

## Results

As shown in Table 1, the mean age and caries and plaque indices were similar for both groups at both the

TABLE 1. Mean Age and Caries and Plaque Indices

	SnF <sub>2</sub> Group	NaF Group
Number of subjects	46	42
Mean final age	15.72 (±1.20)	15.43 (±1.31)
Mean DMFS—initial	6.47 (6.96)	6.08 (6.74)
Mean DMFS—final	10.50 (9.49)	10.55 (7.37)
Mean plaque index—initial	1.20 (0.32)	1.13 (0.34)
Mean plaque index—final	1.13 (±0.42)	1.14 (±0.38)

beginning and end of the 28 months of rinsing. None of the differences approached statistical significance.

Between-group differences in total count and total streptococci were small (Table 2). *S. mutans* were more numerous in plaque from the NaF rinsing group, whereas *Veillonella* were more numerous in the SnF<sub>2</sub> group. *S. mutans* comprised about 11% of the streptococci in plaque in the SnF<sub>2</sub> group and 8% in the NaF group. Analysis of variance (ANOVA) showed that none of these differences reached statistical significance.

To test for the effect of age and sex of the subjects, a series of 2 x 2 x 4 ANOVAs were carried out on the microbiology data with study group, age, and sex as the independent variables. As the numbers varied from cell to cell, both unweighted means and least squares models were used. In no case did the influence of age, sex, or group reach statistical significance.

The total count, total streptococci, percentage of streptococci, total *Veillonella*, and percentage of *Veillonella* correlated positively with Plaque Index scores.

A series of 36 multiple regressions was carried out and showed that the relationships between each of these parameters were similar in the two rinsing groups. We concluded that the correlations and levels of significance were not influenced by the type of fluoride rinse used.

## Discussion

This study revealed no differences in numbers and proportions of *S. mutans* or *Veillonella* in plaque between groups of subjects who had rinsed with either SnF<sub>2</sub> or NaF solutions for 28 months. As reported previously for the larger groups of subjects who participated in this study, Plaque Index scores were significantly lower after 4 months' rinsing with SnF<sub>2</sub> than after rinsing with NaF (Leverett et al. 1981); although this difference was no longer evident after 16 and 28 months of rinsing (Leverett et al. 1984).

Numbers of *S. mutans* in saliva of subjects rinsing with SnF<sub>2</sub> and NaF solutions have been studied by Tinanoff et al. (1983) and Klock et al. (1985). These papers report on different phases of a study of a small group of subjects with high caries prevalence and initially high numbers of *S. mutans* in saliva. Subjects in both groups rinsed twice daily with a solution containing 200 ppm F<sup>-</sup> — slightly less than the 226-242 ppm F concentrations used in our study. Subject compliance was not good and of their original total of 37 subjects, only 12 in the SnF<sub>2</sub> and seven in the NaF group remained in the study after two years. They found that the numbers of *S. mutans* in saliva in the SnF<sub>2</sub> group were reduced at both the one-year and two-year examinations, and that there was essentially no change in the NaF group.

Mouthrinsing twice daily with 0.2% SnF<sub>2</sub> has been found to produce short-term reductions in *S. mutans*

TABLE 2. Numbers and Percentage of Viable Organisms in Plaque from the Two Rinsing Groups

	SnF <sub>2</sub> Group (N = 46)	NaF Group (N = 42)	P Values
Total viable flora	3.45 (±2.98) × 10 <sup>6</sup> *	3.55 (±3.20) × 10 <sup>6</sup>	0.88
Total streptococci	1.16 (1.53) × 10 <sup>6</sup>	1.27 (1.44) × 10 <sup>6</sup>	0.72
<i>S. mutans</i>	1.23 (3.74) × 10 <sup>5</sup>	1.73 (5.56) × 10 <sup>5</sup>	0.62
<i>Veillonella</i>	2.18 (5.82) × 10 <sup>5</sup>	1.91 (5.15) × 10 <sup>5</sup>	0.82
Streptococci % of total	39.6 (52.2)	35.71 (22.32)	0.64
<i>S. mutans</i> % of total	2.2 (4.3)	2.8 (6.5)	0.57
<i>Veillonella</i> % of total	3.6 (6.6)	3.9 (6.2)	0.83
<i>S. mutans</i> % of total streptococci	11.1 (±37.3)	8.0 (±16.7)	0.62

\* Mean number of colony-forming units (±SD).

None of the between-group differences are statistically significant.

levels in both plaque and saliva, whereas no such effects were found with NaF rinses (Svanberg and Rølla 1982).

The effect of SnF<sub>2</sub> mouthrinses has been compared with the effect of topical applications by Svanberg and Westergren (1983) who found that rinsing with 0.2% SnF<sub>2</sub> reduced the *S. mutans* population of both plaque and saliva although the effect had disappeared by two weeks after the end of the rinsing regimen. Topical application of SnF<sub>2</sub>, however, reduced the *S. mutans* population in both plaque and saliva for four weeks after treatment (Svanberg and Westergren 1983).

While it is difficult to interpret the results of these

studies in which the duration and type of treatment, the strength of the solutions, and the caries activity of the subjects all varied substantially, it is possible to draw some general conclusions. It seems that rinsing with SnF<sub>2</sub> solutions (0.05% or stronger) reduces *S. mutans* levels in plaque,<sup>2</sup> but that the effect is relatively modest and tends to diminish with time. It was not evident two weeks after the cessation of rinsing (Svanberg and Westergren 1983) and, when daily rinsing was continuous, tended to diminish over time (Tinanoﬀ et al. 1983; Klock et al. 1985) and to have essentially disappeared by 28 months as reported in the present study. The concentration of SnF<sub>2</sub> and the frequency of rinsing varied in these different studies from 200 ppm F twice a day (Tinanoﬀ et al. 1983; Klock et al. 1985) to 800 ppm F twice a day (Svanberg and Rølla 1982; Svanberg and Westergren 1983), but the clinical effects do not appear to have differed substantially.

All reported studies have failed to demonstrate any reduction in plaque or salivary *S. mutans* by NaF rinses with the same range of F content as the SnF<sub>2</sub> rinses discussed here.<sup>3</sup> It seems likely, therefore, that it is not the fluoride but the tin which causes the reduction in numbers of *S. mutans*.

Daily rinsing with stannous fluoride thus appears to cause short-term reductions of *S. mutans* in plaque. This effect diminishes progressively with time and, as reported in the present study, is no longer statistically significant after 28 months of daily rinsing. Further research is needed to determine whether or not this beneficial effect can be maintained by intermittent periods of rinsing or by periodic substitution with other antiplaque rinses.

<sup>2</sup>Svanberg and Rølla 1982; Svanberg and Westergren 1983; Tinanoﬀ et al. 1983; Klock et al. 1985)

<sup>3</sup>Svanberg and Rølla 1982; Tinanoﬀ et al. 1983; Klock et al. 1985.

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